NEW YORK ENTOMOLOGICAL SOCIETY
91(4), 1983, pp. 342–347

# MICROCLIMATE OBSERVATIONS AND DIEL ACTIVITIES OF CERTAIN CARRION ARTHROPODS IN THE CHIHUAHUAN DESERT

KENNETH SCHOENLY
Department of Biology, Angelo State University,
San Angelo, Texas 76909

*Abstract.*—Diel activity cycles of carrion arthropods and microclimate in and around carcasses were recorded using a bait trap and electronic telethermometer apparatus, respectively. Arthropod collections and temperature data were gathered for 24 hours each on 2 collection dates in 12 consecutive 2-hr intervals. Ants, histerid and dermestid beetles were active throughout the 24 hr period. Temporal segregation was observed between diurnal muscoid flies and nocturnal trogid beetles. Small numbers of maggots emerged from carcasses between 1 AM and 9 AM MDT. In the microclimate experiments, highest temperatures were noted on the soil surface (50°C), whereas the carcass surface (47°C), carcass interior (42°C), and surrounding air temperatures (36°C) were notably lower. Highest mean temperatures were recorded in the carcass interior and were probably attributable to internal heat generation by bacteria and maggots.

Most previous studies on carrion arthropods have addressed aspects of insect phenology and succession, trophic relationships and stages of decomposition. Other studies have examined the influence of environmental factors on rate of decomposition (Nabaglio, 1973), arthropod succession (Payne, 1965), flight activities of carrion beetles (Shubeck, 1975), and carcass microclimate (Reed, 1958; Payne, 1965). However, diel activities among carrion arthropods relative to microclimates in and around carcasses have received only casual attention. Diel variations in the carrion fauna (Reed, 1958; Payne, 1965; Shubeck, 1971) indicate that some arthropods (histerids, ants, silphids, phalangids, and dipterous larvae) that are active on carcasses by day also are nocturnal; whereas other taxa are almost exclusively diurnal (adult dipterans) or nocturnal (trogid beetles).

This paper supplements an earlier study (Schoenly and Reid, 1983) on the community structure of carrion arthropods in the northern Chihuahuan desert. Here I describe microclimate and diel activity patterns of arthropods on rabbit carrion during peak periods of arthropod diversity and carcass decomposition.

## MATERIALS AND METHODS

The study area was located in a desert shrub community adjacent to the Franklin Mnts in El Paso County, Texas. In this region of the Chihuahuan

The publication costs of this article were defrayed in part by page charge payment. This article must therefore be hereby marked *"Advertisement"* in accordance with 18 U.S.C. §1734 solely to indicate this fact.

desert, mean annual precipitation is 211 mm, temperatures range from −21° to 43°C, and the growing season averages 238 days (Norquest, 1941).

Observations of diel activity and carcass microclimate were made using a bait trap and telethermometer apparatus. The trap consisted of a square wooden box and was designed to collect arthropods immigrating to and emerging from carcasses (Schoenly, 1981). Arthropods were collected from the trap with a system of eight killing jars charged with an ethylene glycol mixture (Morrill, 1975). Adult blacktailed jackrabbits (*Lepus californicus* Gray) with an average mass of 2,250 gm were used for bait and placed in the trap. Sampling was begun when maximum arthropod diversity was reached; a period of 4–6 days after carcass placement (Schoenly and Reid, 1983). Arthropod collections and temperature data were gathered for a 24 hr period during 12 consecutive 2-hr intervals. Two experiments, using one rabbit carcass each, were conducted on July 26–27, and August 25–26, 1980. Penetration and contact thermocouples were attached to the carcass to monitor internal and surface temperatures. Ambient air and soil surface temperatures were monitored by securing thermocouples to the top and bottom of a 1-meter vertical post (Fig. 1). A Yellow Springs Instruments telethermometer was used to measure temperature. To maximize sampling efficiency, collecting jars were changed with fresh preserving fluid during each visit.

Patterns of temporal utilization among carrion arthropod taxa were compared using Levins (1968) measure of niche breadth:

$$B_i = 1/\sum_j p_{ij}^2$$

where $p_{ij}$ is the importance value (proportion of individuals) of the ith species found on j resource units. The resource units in this study refer to time of carcass visitation by arthropods; thus, there were 12 2-hr resource units. Niche breadth values range from 0 to 1. A value of 1 indicates carrion utilization on all 12 resource units, whereas a value approaching 0 indicates very restricted use of carrion. Correlation statistics were used to test for significant differences between variables.

## RESULTS AND DISCUSSION

Activity distributions of 5 arthropod taxa and temperature records pooled from the 2 collection dates are summarized in Figure 2. Although a brief summer shower temporarily interrupted arthropod activity on July 26, species composition overlapped considerably in both trials. Arthropods collected from the July and August experiments included: dipterans (97 and 268), hister beetles (18 and 109), ants (36 and 30), trogid beetles (4 and 10) and dermestids (3 and 17). The only other notable difference between the 2 experiments was the absence of maggots in the July trial.

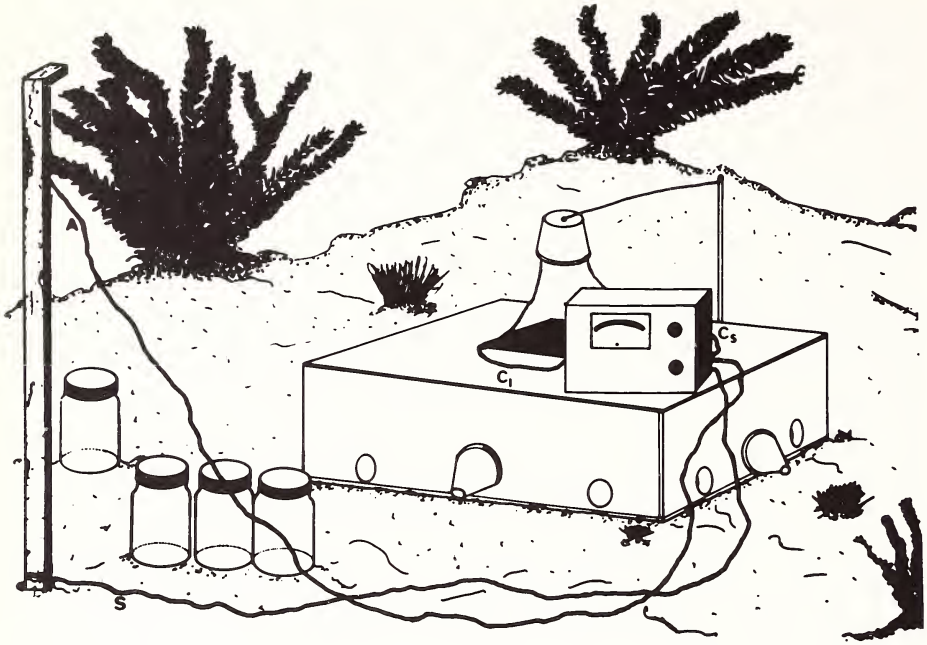
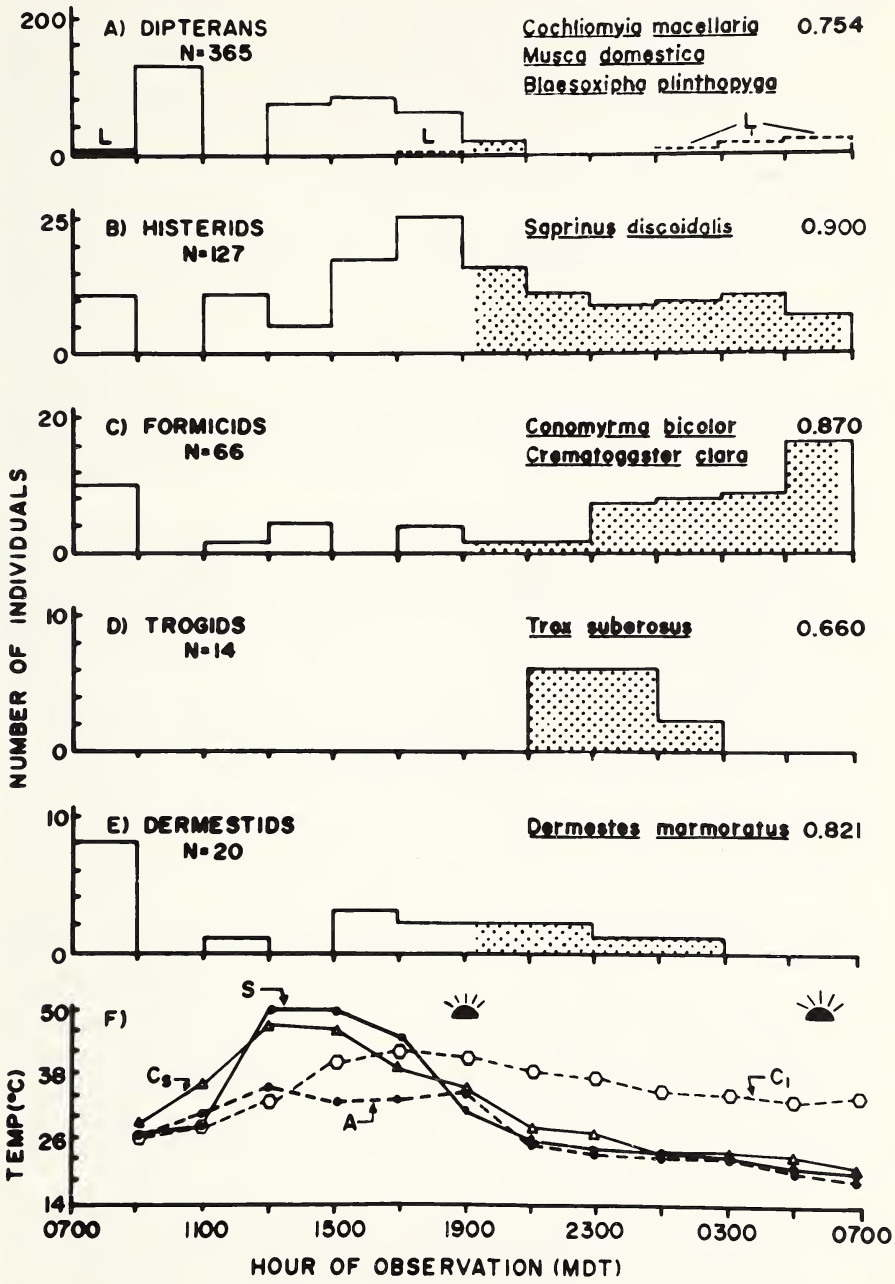



Fig. 1. Diagrammatic representation of the bait trap and telethermometer apparatus used for recording microclimate data and diel activity patterns of arthropods frequenting rabbit carrion. The height of the vertical post is 1 meter. A = ambient air, S = soil surface, $C_s$ = carcass surface, and $C_i$ = carcass interior thermocouples.

Adult dipterans were collected from the trap from 9 AM to 9 PM, and no activity occurred after 9 PM (Fig. 2A). A relatively high niche breadth value (0.754) corresponded to a uniform pattern of diurnal activity (1–7 PM) and a large density of individual flies, particularly from 9 to 11 AM. The relationship between diurnal activity of adult flies and air temperature was significant and negative ($r = -0.62$, $P < 0.05$). The calliphorid, *Cochliomyia macellaria* (Fabricius) was the most abundant species observed (N = 329), followed by *Musca domestica* L. (Muscidae) (24) and the sarcophagid, *Blaesoxipha plinthopyga* (Wiedemann) (12). In addition, small numbers of

→

Fig. 2. (A–E) Number of arthropods collected from jackrabbit carrion during periods of active decomposition (days 4–6 after placement) in summer, 1980. Numbers in the right margin of each graph refer to values of temporal niche breadth (see text). Shaded portions indicate nocturnal periods. L = fly larvae. (F) Microclimate temperatures taken on the carcass and near the trap; S = soil surface, A = ambient air, $C_s$ = carcass surface and $C_i$ = carcass interior temperatures. Partial sun symbols indicate approximate periods of sunset and sunrise (MDT).


A) DIPTERANS
N=365
Cochliomyia macellaria 0.754
Musca domestica
Blaesoxipha plinthopyga
B) HISTERIDS
N=127
Saprinus discoidalis 0.900
C) FORMICIDS
N=66
Conomyrma bicolor 0.870
Crematogaster clara
D) TROGIDS
N=14
Trox suberosus 0.660
E) DERMESTIDS
N=20
Dermestes marmoratus 0.821
NUMBER OF INDIVIDUALS
F)
S
A
TEMP(°C)
HOUR OF OBSERVATION (MDT)
0700
1100
1500
1900
2300
0300
0700

dipteran larvae (N = 22) emerged from carcasses at night between 1 and 7 AM and continued into late morning (Fig. 2A).

The histerid beetle, *Saprinus discoidalis* LeConte, was second in abundance (N = 127) and had the highest niche value of all the taxa considered (0.900). This species was active throughout the day and night, but had a distinct peak of activity 2 hr before sunset (Fig. 2B).

Of the ants observed, *Crematogaster clara* Mayr and *Conomyrma bicolor* (Wheeler) were the most frequent visitors to carrion. Ants were least active during daylight hours, whereas nocturnal observations showed a rapid increase in numbers beginning at 11 PM with a prominent peak 1 hr before sunrise (Fig. 2C). Ant activity was negatively correlated with increasing air ($r = -0.63$, $P < 0.02$) and soil temperatures ($r = -0.56$, $P < 0.05$). A significant positive relationship was observed between nocturnal ant activity and dipteran larvae emergence from carrion ($r = 0.93$, $P < 0.01$) suggesting that ants were preying on the larvae. Predation by ants on larvae in carrion has been reported previously from the Chihuahuan desert (McKinnerney, 1978; Schoenly and Reid, 1983) and elsewhere.

Trogid beetles (*Trox suberosus* Fabricius) were collected in small numbers (N = 14) during nocturnal periods only from 9 PM to 3 AM (Fig. 2D), and had the lowest value of temporal niche breadth (0.660). During the heat of the day, trogids remained inside or under carcasses where subdued light conditions prevailed.

A total of 20 dermestid beetles (*Dermestes marmoratus* Say) were collected between 7 AM and 3 AM. Eight or 40% of the individuals collected were captured in the 2 hr between 7 AM and 9 AM (Fig. 2E).

Smaller numbers of other arthropods (not shown in Fig. 2) also were collected including 3 solpugids (*Eremobates marathoni* Muma), 2 arachnids (*Syspira longipes* [Simon]), and a staphylinid beetle (*Creophilis maxillosus* [Linné]).

Highest temperatures were recorded on the soil (50°C) and carcass surfaces (47°C) between 1–3 PM, whereas carcass interior and ambient air temperatures peaked later at lower temperature (42° and 36°C, respectively). However, the mean temperature of the interior of carcasses (35°C) was much higher than the mean temperature of the carcass surface (31°C) and the surrounding soil surface temperatures (30.6°C) (Fig. 2F). Payne (1965) stated that rising temperatures in the carcass during active and advanced decay stages are attributable to the actions of bacteria and maggots. My data would seem to support this hypothesis.

My results indicated that diel variations in the desert carrion fauna are similar to those reported by Reed (1958) and Payne (1965) in temperate forest ecosystems. Higher environmental temperatures do not appear to restrict arthropod activity in or around carrion, at least in those taxa studied here. Temporal segregation was noted in 2 taxa (flies, trogids) and densities

of all 5 taxa peaked at different times. Analysis of feeding habits revealed that even among ecologically similar carrion taxa patterns of diel activity differed. Among the necrophagous taxa, trogid beetles were exclusively nocturnal, whereas dipterans and dermestids were both active after sunrise but displayed distinct peaks of activity at different times (9–11 AM and 7–9 AM, respectively). Of the predaceous arthropods, hister beetles and ants both are known to prey on maggots (Schoenly and Reid, in press and references therein), however, peak densities occurred at dusk for beetles and dawn for ants. Members of the carrion community in other regions may show similar patterns in carcass utilization.

ACKNOWLEDGMENTS

I thank R. J. Gagńe, A. C. F. Hung, J. M. Kingsolver, Systematic Entomology Laboratory, USDA; P. Vaurie, L. H. Herman, American Museum of Natural History; V. Roth, R. S. Beal, Jr., and M. Muma for their determinations.

LITERATURE CITED

Levins, R. 1968. Evolution in Changing Environments. Some Theoretical Explorations. Princeton Univ. Press.

McKinnerney, M. 1978. Carrion communities in the northern Chihuahuan desert. Southwest. Nat. 23:563–576.

Morrill, W. L. 1975. Plastic pitfall trap. Environ. Entomol. 4:596.

Nabaglio, L. 1973. Participation of invertebrates in decomposition of rodent carcasses in forest ecosystems. Ekologia Pol. 21(18):251–270.

Norquest, C. E. 1941. Climate of Texas. Pages 1129–1146 *in:* Climate and Man, Yearbook of Agriculture. U.S.D.A., Washington, D.C.

Payne, J. 1965. A summer carrion study of the baby pig *Sus scrofa* Linnaeus. Ecology 46: 592–602.

Reed, H. B., Jr. 1958. Study of dog carcass communities in Tennessee, with special reference to the insects. Am. Midl. Nat. 59:213–245.

Schoenly, K. 1981. Demographic bait trap. Environ. Entomol. 10:615–617.

Schoenly, K. and W. Reid. 1983. Community structure of carrion arthropods in the Chihuahuan desert. J. Arid Environ. 6:253–263.

Shubeck, P. P. 1971. Diel periodicities of certain carrion beetles (Coleoptera: Silphidae). Coleopt. Bull. 25:41–46.

Shubeck, P. P. 1975. Flight activities of certain carrion beetles: *Silpha noveboracensis,* Staphylinidae, Histeridae. The William L. Hutcheson Memorial Forest Bull. 3(2):40–43.

Received April 25, 1983; accepted August 17, 1983.